WATER FOR LIFE

Water is essential for life, but according to UNICEF and the World Health Organisation[1], one in every three people globally still do not have access to safe drinking water. Further, more than half of the world does not have access to safe sanitation.

As a result, in 2017, almost 1.6 million people around the world died from diarrheal diseases, one-third of whom were children under five years old[2]. Such diarrheal diseases are the third leading cause of child mortality globally, and are closely linked to unsafe drinking water. It is estimated that even in 2020, 1.2 million children died from diarrhea and related diseases alone[3]. This is the equivalent of one child every 26 seconds.

Many other diseases are also caused by the consumption of water contaminated with bacteria, viruses, and other pathogens; illnesses such as cholera, hepatitis and typhoid are some example. Indeed, half of the world's diseases are transmitted by or through contaminated water, and with 144 million people world-wide still drinking untreated surface water, this is a major challenge for everyone.

CHLORINE FOR WATER

The treatment of contaminated water to make it safe is essential for human health and well-being and is a key tool for preventing waterborne disease. One solution consists of disinfecting water using chlorine and chlorinated products.

HISTORY

Scientific papers on the use of chlorine to make water 'germ-free' were published as early as 1894, with early water disinfection using chlorine occurring in the UK in 1897. Following the use of chlorine in municipal drinking water in the USA in New Jersey in 1908, typhoid fever rates declined dramatically. By 1941, the US Public Health Service estimated that 85% of US drinking water supplies were being chlorinated, causing the national death rate from typhoid fever to fall to lower than 1 in 100,000[4]. In 1997, Life magazine called the filtration of drinking water and the use of chlorine "probably the most significant public health advance of the millennium"[5].

DISEASES TO BE AVOIDED

Chlorine-based disinfectants have been used for over a century to provide communities around the world with safe and reliable water, saving countless lives. These vital sanitising chemicals are effective against a wide variety of disease-causing bacteria, viruses, and parasites. One such disease is cholera, a serious intestinal illness caused by bacteria. Cholera can infect people when they drink faecal-contaminated water. Chlorine helps to stop this disease by destroying the cholera bacteria. Another waterborne illness is typhoid; like cholera, this remains a problem in developing countries where water treatment is often lacking or absent.

FORMS OF CHLORINE DISINFECTANTS

Chlorine can be safely applied to water as either elemental chlorine (chlorine gas) or via the use of sodium hypochlorite (liquid 'bleach') or calcium hypochlorite (as tablets or granules), making it very versatile. All of these forms generate a 'free chlorine' residual that attacks germs in the water to disinfect it and make it safe to drink.

Whilst other technologies to disinfect water exist, only chlorinated disinfectants leave this beneficial 'residual' level in the treated water, further protecting it during distribution and short-term storage. This residual is easily monitored and is an excellent indicator of overall water quality. Chlorine for drinking water is also low-cost and "scalable"; that is, appropriate to serve the needs of small, remote villages as well as large cities. Chlorinated disinfectants can also be added to cisterns that collect rainwater for remote properties that are far from distribution pipes or even to a single tap!

DISINFECTION BY-PRODUCTS

Like all other disinfectants, chlorine kills harmful pathogens but can react with any organic materials in the water, such as decaying leaves. These form disinfection by-products or DBPs. Much more is known about

chlorinated DBPs than those associated with other disinfectants. Studies confirm that chlorinated DBPs do not cause cancer at the very low (parts per million or billion) levels typically found in treated drinking water, and that these DBPs do not remain or build up in the environment. In addition, under "environmentally relevant" conditions, the use of chlorine for drinking water does not lead to the formation of highly chlorinated chemicals such as dioxins.

Chlorinated DBP levels are also easily managed by water providers by using standard water treatment techniques, such as filtration and aeration and removal of organic matter prior to adding chlorine.

The International Panel on Chemical Safety is keen to remind people that "the health risks from these by-products at the levels at which they occur in drinking water are extremely small in comparison with the risks associated with inadequate disinfection. Thus, it is important that disinfection not be compromised in attempting to control such by-products"[6]. Chlorine therefore remains a vital part of any tool box to treat drinking water.

CHLORINE USE BEYOND CLASSIC WATER DISINFECTION

Chlorine is not only useful in disinfecting drinking water though. Any disinfected water can be carried to the tap using another product of chlorine chemistry, PVC or polyvinyl chloride. PVC pipes are lighter than many other pipe-materials, requiring less energy for transporting them, and are very easy to install. Once in place, they require limited maintenance, are immune from corrosion or rusting, are strong, easily recycled, and have a life-span of well over 100 years.

During the global Covid-19 pandemic, when used responsibly and correctly, chlorine-based disinfectants were successfully used to disinfect frequently touched surfaces and to treat wastewater where the virus was also found to be present. It even played a role as people returned to work to cleanse building pipes, where water had been stagnant for a while, to reduce the risk of Legionella. This is not to mention the role of chlorine chemistry in making various materials for protective and medical treatment equipment.

CHLORINE FOR SUSTAINABILITY

For disinfecting wastewater, chlorine must be removed prior to release to receiving waters. This is easily achievable. Wastewater disinfection helps to both prevent waterborne disease and damage to aquatic environments receiving any treated wastewater. As global demand for water increases (e.g. for irrigation, industrial processing, drinking water, etc.), or with water resources become increasingly strained due to the impacts of climate change, water re-use (i.e. use of highly treated wastewater as a water supply) will become even more essential. Chlorination will help to protect and conserve this important global resource.

Access to safely managed water and sanitation for everyone on our planet is one of the 17 sustainable development goals (SDGs) set by the UN in 2015. In particular, chlorine plays a vital role in achieving SDG 6 by keeping communities around the world safe, healthy and readily supplied with disinfected drinking water.

Access to such safe drinking water also provides other side-benefits to help achieve other SDGs. For example, when safe drinking water is readily accessible, people have more time for other activities as they do not need to walk long distances to collect "clean" water from wells and surface waters such as lakes and rivers. This helps reduce poverty (SDG 1) as more people can go to work and school (SDG 4).

Sensitive marine environments can also be protected. As ships sail across the globe, they can transport plants and animals from other areas in their stabilising ballast water. These "alien" (or invasive) organisms often have the potential to out-compete local species and damage local ecosystems. By treating ballast water with chlorine-based disinfectants, invasive species are controlled, reducing their impact on the environment, a key part of SDG 14.

CHLORINE FOR LIFE

The use of chlorine to disinfect drinking water has been called one of the greatest public health advances in history. By harnessing this vital chemistry, water can be made safe and the quality of life enhanced on many levels now, and for generations to come.

1. World Health Organisation (2019). "1 in 3 people globally do not have access to safe drinking water". Published online at who.int/news-room/detail/18-06-2019-1-in-3-people-globally-do-not-have-access-to-safe-drinking-water-unicef-who. Last accessed January 2020.
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4. M.J. McGuire (2012) "The Chlorine Revolution: Water Disinfection and the fight to save lives". American Water Works Association
5. Life Magazine (1997). Autumn Special Issue. Top 100 discoveries/ events of the millennium.
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